2016 Aliceville Reservoir Report

Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Rivers and Reservoirs Unit
March 2020

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2016

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Upper Tombigbee River Basin

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LIST OF ACRONYMS

A&I	Agricultural and Industrial Water Supply Use Classification
ADEM	Alabama Department of Environmental Management
AGPT	Algal Growth Potential Test
chl *a*	Chlorophyll *a*
DO	Dissolved Oxygen
F&W	Fish and Wildlife
MAX	Maximum
MDL	Method Detection Limit
MIN	Minimum
MSC	Mean Standing Crop
NTU	Nephelometric Turbidity Units
OAW	Outstanding Alabama Waters
ONRW	Outstanding National Resource Water
PWS	Public Water Supply
QAPP	Quality Assurance Project Plan
RRMP	Rivers and Reservoirs Monitoring Program
S	Swimming and Other Whole Body Water-Contact Sports
SD	Standard Deviation
SOP	Standard Operating Procedures
TEMP	Temperature
TN	Total Nitrogen
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSI	Trophic State Index
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

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INTRODUCTION

With the completion of the Tom Bevill Dam in 1980, Aliceville Reservoir joined the Tennessee-Tombigbee Waterway (Tenn-Tom) system that connects the Tennessee River with the Tombigbee River. Located in Pickens County, Aliceville Reservoir is the first Alabama reservoir on the Tenn-Tom system. The 234-mile waterway flows south from Pickwick Lake on the Tennessee River, down through northeast Mississippi and west Alabama to connect with the established Warrior-Tombigbee navigation system at Demopolis, Alabama. After 12 years of construction, the waterway opened to commercial traffic in January 1985.

The Alabama Department of Environmental Management (ADEM) monitored Aliceville Reservoir as part of the 2016 assessment of the Escatawpa, Mobile, and Tombigbee River basins under the Rivers and Reservoirs Monitoring Program (RRMP). ADEM began monitoring lake water quality statewide in 1985, followed by a second statewide survey in 1989. In 1990, the Reservoir Water Quality Monitoring Program (now known as RRMP) was initiated by ADEM. The current objectives of this program are to provide data that can be used to assess current water quality conditions, to identify trends in water quality conditions, and to develop Total Maximum Daily Loads (TMDLs) and water quality criteria. Descriptions of all RRMP monitoring activities are available in ADEM's 2017 Monitoring Strategy (ADEM 2017).

Aliceville Reservoir was placed on Alabama's 1996 Clean Water Act (CWA) §303(d) list of impaired waters for not meeting its Swimming (S)/Fish & Wildlife (F&W) water use classifications. The reservoir was listed for impairments caused by organic enrichment/dissolved oxygen (OE/DO). A total maximum daily load (TMDL), developed to address this impairment, was approved by the United States Environmental Protection Agency (USEPA) in 2008.

The purpose of this report is to summarize data collected at three stations in Aliceville Reservoir during the 2016 growing season and to evaluate trends in mean lake trophic status and nutrient concentrations using ADEM's historic dataset. Monthly and mean concentrations of nutrients [total nitrogen (TN); total phosphorus (TP)], algal biomass/productivity [chlorophyll *a* (chl *a*); algal growth potential testing (AGPT)], sediment [total suspended solids (TSS)], and trophic state [Carlson's trophic state index (TSI)] were compared to ADEM's historical data and established criteria.

METHODS

Sampling stations were selected using historical data and previous assessments (Figure 1). Specific location information can be found in Table 1. Aliceville Reservoir was sampled in the dam forebay, in the upper reservoir just upstream of the Lindsey Creek confluence near the state line, and in the Coal Fire Creek embayment.

Water quality assessments were conducted at monthly intervals, April-October. All samples were collected, preserved, stored, and transported according to procedures in the ADEM Field Operations Division Standard Operating Procedures (ADEM 2017), Surface Water Quality Assurance Project Plan (ADEM 2017), and Quality Management Plan (ADEM 2018).

Mean growing season TN, TP, chl *a*, and TSS were calculated to evaluate water quality conditions at each site. Monthly concentrations of these parameters were graphed with the closest available USGS flow data and ADEM's previously collected data to help interpret the 2016 results.

Figure 1. Aliceville Reservoir with 2016 sampling locations. A description of each sampling location is provided in Table 1.

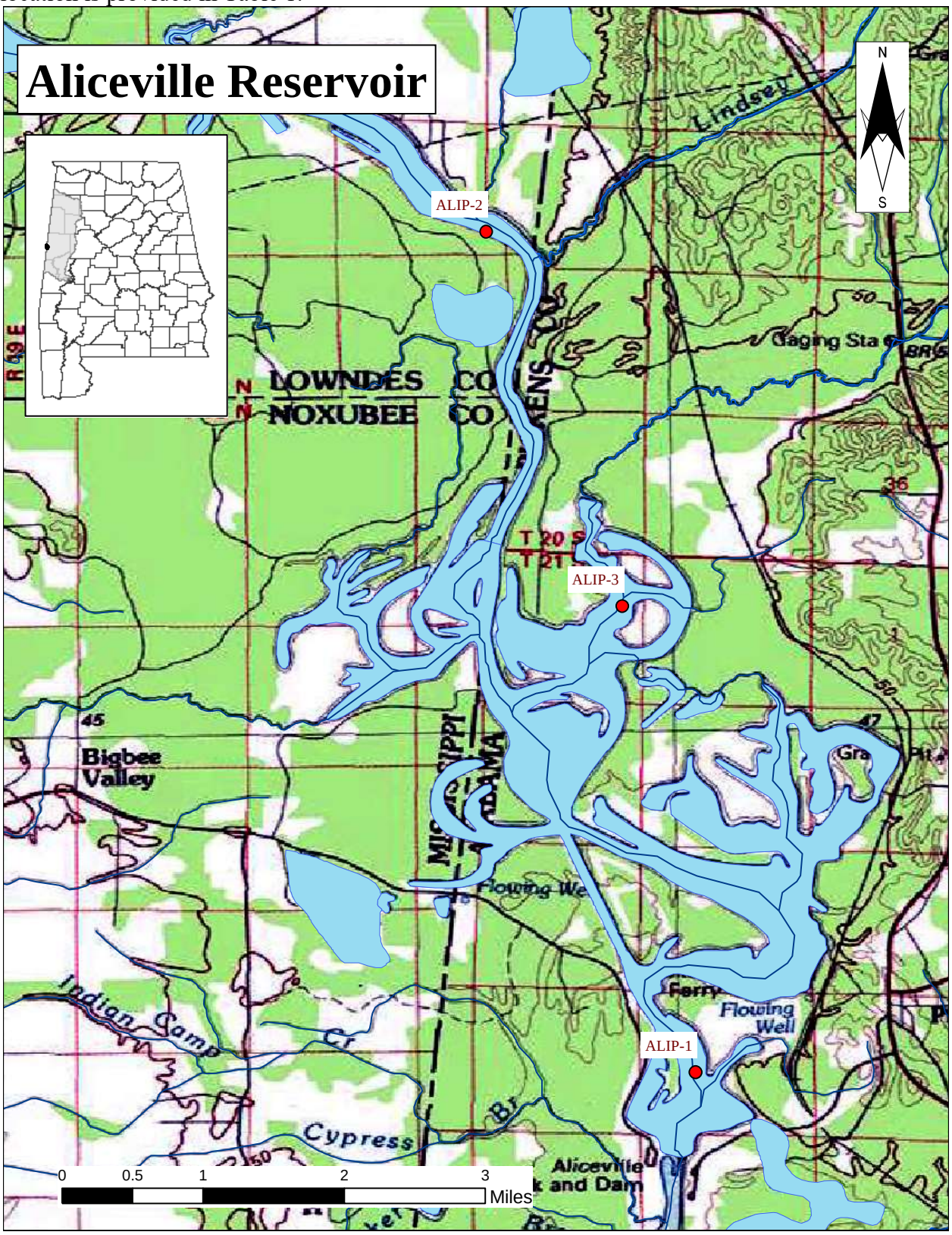


Table 1. Descriptions of the 2016 monitoring stations in Aliceville Reservoir.

HUC	County	Station Number	Report Designation	Waterbody Name	Station Description	Chl *a* Criterion	Latitude	Longitude
Aliceville Reservoir								
031501050502	Pickens	**ALIP-1	Lower	Tombigbee R	Deepest point, main river channel, dam forebay.	18 µg/L	33.2191	-88.2861
031501050308	Pickens	ALIP-2	Upper	Tombigbee R	Deepest point, main river channel, immediately upstream of Lindsey Branch confluence.		33.3030	-88.3029
031501050203	Pickens	ALIP-3	Coal Fire	Coal Fire Ck	Deepest point, main creek channel, Coal Fire Creek embayment, approximately one mile upstream of confluence with Tombigbee River.		33.2669	-88.2936

** Growing season mean Chl a criterion implemented at this station in 2008

RESULTS

Growing season mean graphs for TN, TP, chl *a* and TSS are provided in this section (Figures 2 and 3). Monthly graphs for TN, TP, chl *a*, TSS, dissolved oxygen (DO), and TSI are also provided (Figures 4-8 and 11). Mean monthly discharge is included in monthly graphs for TN, TP, chl *a*, TSS, and TSI as an indicator of flow and retention time in the months sampled. AGPT results appear in Table 2. Depth profile graphs of temperature, DO, and conductivity appear in Figures 9 and 10. Summary statistics of all data collected during 2016 are presented in Appendix Table 1. The table contains the minimum, maximum, median, mean, and standard deviation of each parameter analyzed.

Stations with the highest concentrations of nutrients, chlorophyll *a*, and TSS are noted in the paragraphs to follow. Though stations with lowest concentrations may not always be mentioned, review of the graphs included in this report will indicate stations that may be potential candidates for reference waterbodies and watersheds.

In 2016, the highest mean growing season TN value was calculated for the upper station (Figure 2). With the exception of 2016, the Coal Fire Creek embayment's mean growing season TN concentrations were lower than both mainstem stations in all growing seasons sampled. Mean growing season TN concentrations were lower at all three stations compared to those from 2014. The highest monthly TN concentrations in the upper station and in Coal Fire Creek were measured in June, while the highest monthly TN concentration in the lower station occurred in May. (Figure 4). In the upper station, monthly TN concentrations were near historic mean values for the majority of the 2016 growing season with the exception of May, September, and October. The monthly TN concentrations in the lower station fell below historic mean values in all months except April and May. Coal Fire Creek had monthly TN concentrations near historic means throughout the growing season. Historic low monthly TN concentrations occurred at the upper station in October and at the lower station in September.

In 2016, the highest mean growing season TP value was in the lower station. However, there was little variance in the mean TP concentrations among the three stations sampled (Figure 2). The 2016 mean growing season TP concentrations were the lowest they have been since

monitoring began. The highest monthly TP concentrations occurred during April and May in the upper, lower, and Coal Fire Creek stations (Figure 5). Monthly TP concentrations were below historic means the entire growing season at all three stations during 2016 sampling. Historic low monthly concentrations were measured in June, July, August, and October at the upper station and during July and September at the lower station. Historic lows were also measured at the Coal Fire Creek station in June, July, September, and October.

In 2016, the highest growing season mean chl *a* was in the upper station (Figure 3). All three stations showed a decrease in mean growing season chl *a* concentrations from 2014 to 2016. The mean chl *a* concentration in the lower Aliceville station was below the established criterion of 18 µg/L (ADEM Admin. Code R. 335-6-10-.11). The highest monthly chl *a* concentration at all three stations occurred in the month of June (Figure 6). Monthly chl *a* concentrations were near or below historic means during most months.

In 2016, the highest mean growing season TSS value was in the lower station (Figure 3). However, there was little variance in mean TSS among the three stations. Growing season mean TSS concentrations in the upper and lower stations were much lower than concentrations measured in 2014. Monthly TSS concentrations in the upper and lower stations were highest in the spring and then decreased in the summer and fall (Figure 7). Historic monthly low occurred in July and October in the upper station, in August in Coal Fire Creek, and in July in the lower station.

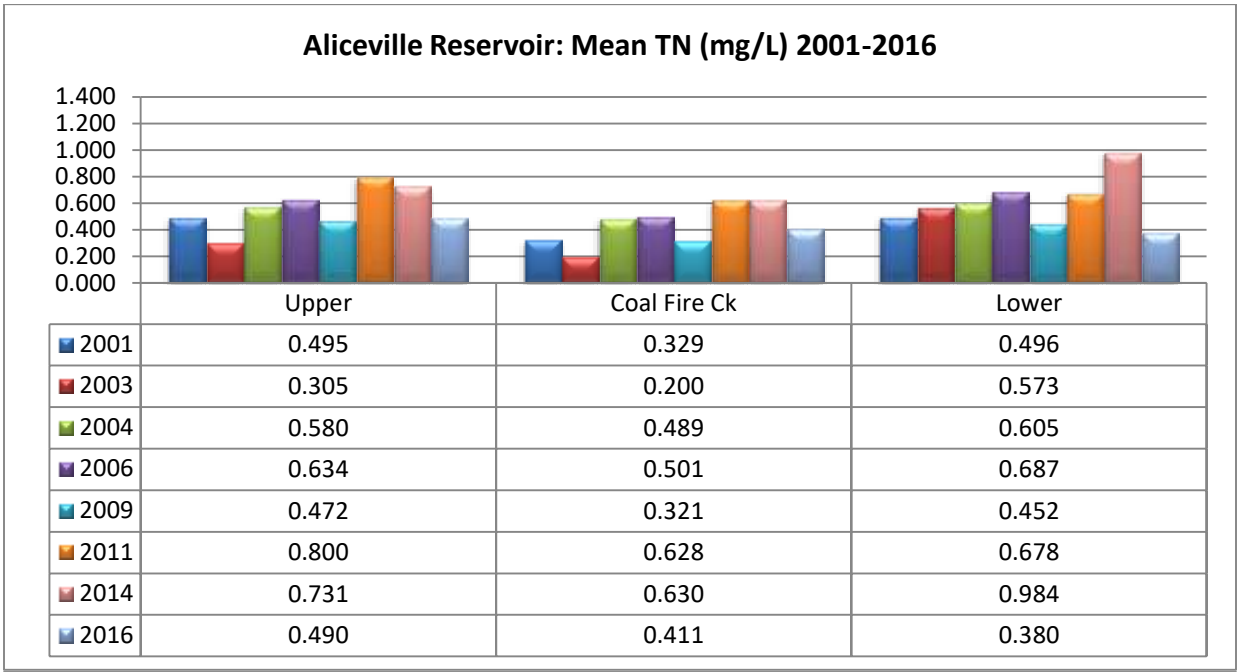
In 2016, AGPT results indicated the reservoir was nitrogen-limited at both mainstem stations, which is consistent with data from previous growing seasons (Table 2). The MSC value at the lower station was 2.93 mg/L, which is below 5 mg/L, the value defined as protective of reservoir and lake systems (Raschke and Schultz 1987). The mean MSC value at the upper station was 3.14 mg/L which is below 20 mg/L, the value that Raschke et al. (1996) defined as protective of flowing stream and river systems.

Dissolved oxygen (DO) concentrations at the lower station were below the ADEM Criterion (ADEM Admin. Code R. 335-6-10-.09) limit of 5.0 mg/L at 5.0 ft (1.5 m) in June. Concentrations were also below criterion at Coal Fire Creek in June and July (Figure 8). DO concentrations met criterion at the upper station April-October. Profiles of DO concentrations at

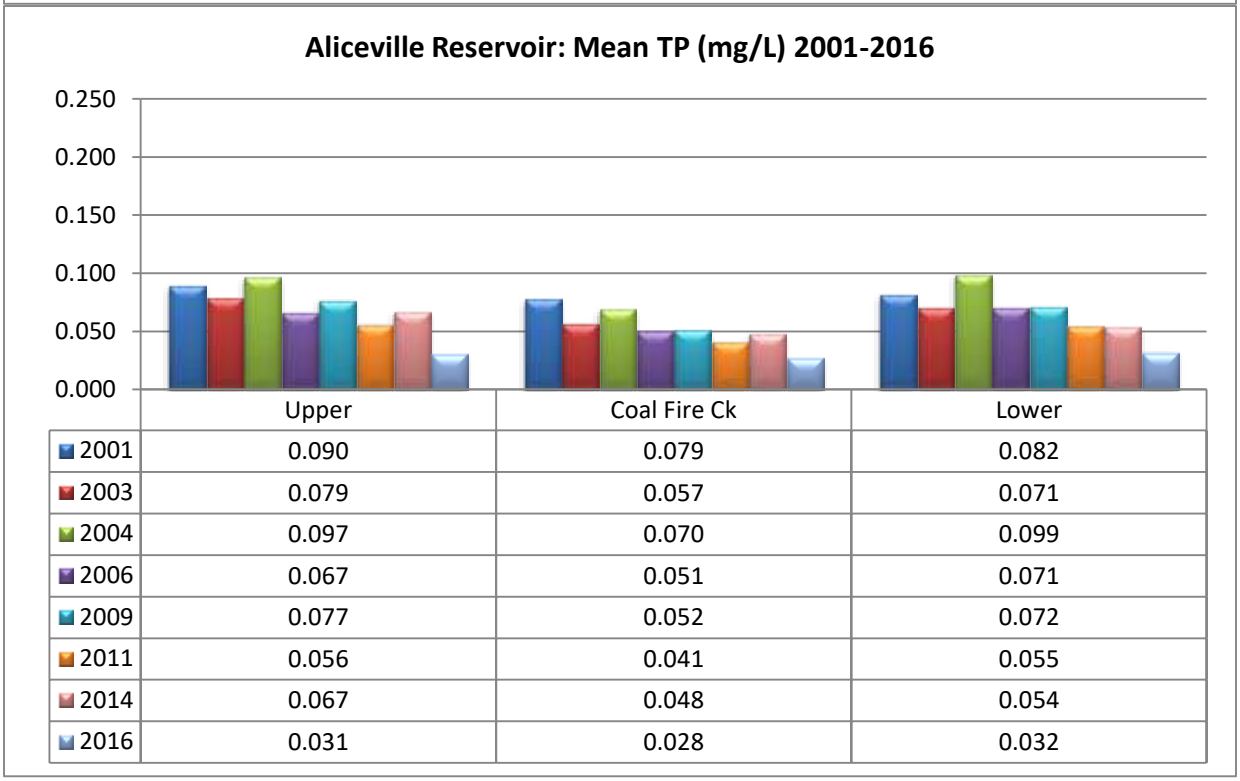
the lower station indicate the water column was slightly stratified July-September, while the upper station was generally mixed most months with slight stratification in July (Figures 9 and 10). Profiles indicate highest water temperatures were reached in June and July at both stations.

TSI values were calculated using monthly chl *a* concentrations and Carlson's Trophic State Index. The upper and lower stationsd were eutrophic during the 2016 growing season (Figure 11). Coal Fire Creek was eutrophic April-September, but it was slightly mesotrophic in October.

Figure 2. Mean growing season TN and TP measured in Aliceville Reservoir, April-October, 2001-2016. Bar graphs consist of mainstem and embayment stations, illustrated from upstream to downstream as the graph is read from left to right.

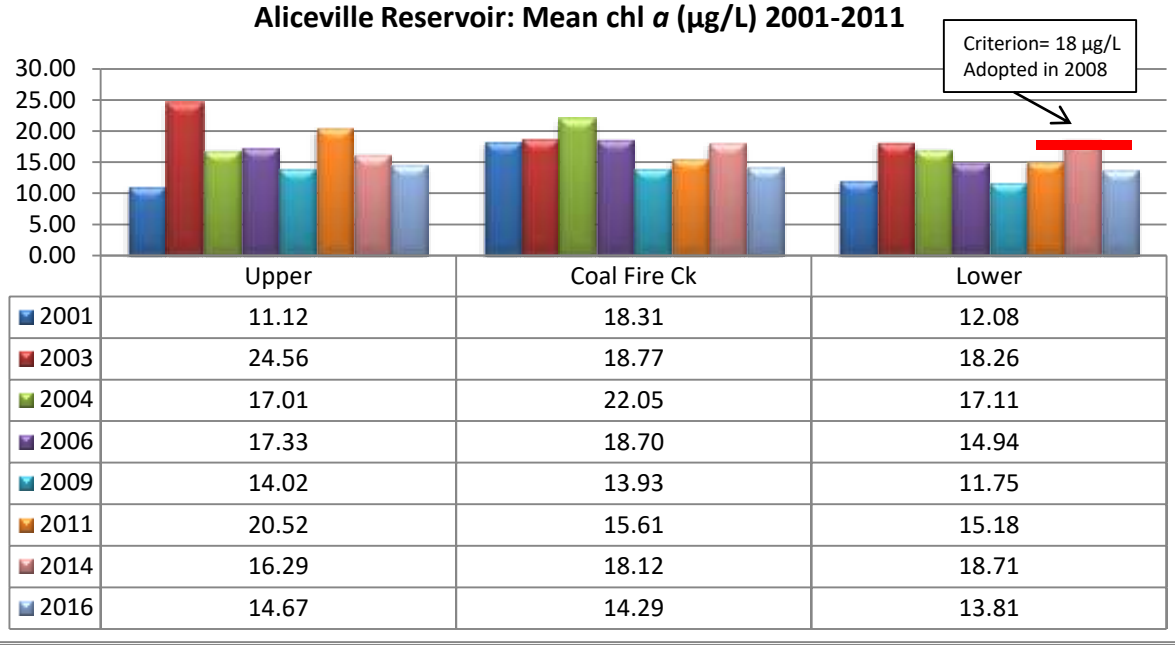


	Upper	Coal Fire Ck	Lower
2001	0.495	0.329	0.496
2003	0.305	0.200	0.573
2004	0.580	0.489	0.605
2006	0.634	0.501	0.687
2009	0.472	0.321	0.452
2011	0.800	0.628	0.678
2014	0.731	0.630	0.984
2016	0.490	0.411	0.380

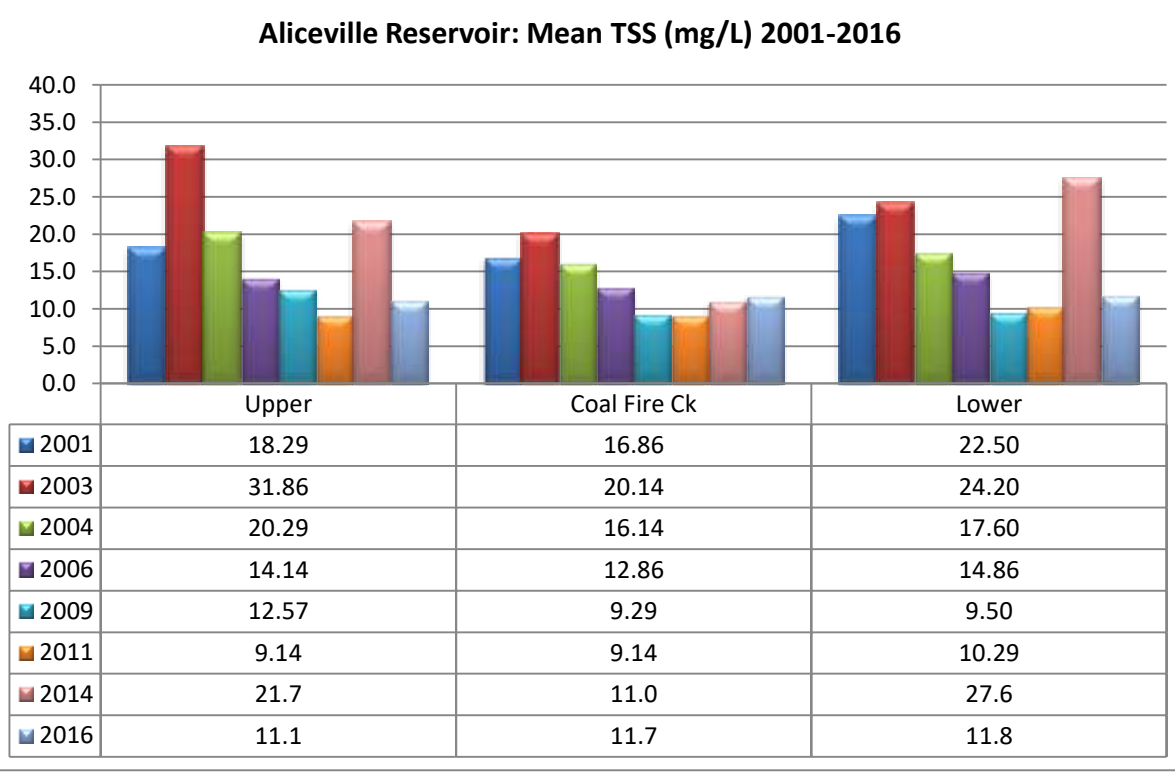


	Upper	Coal Fire Ck	Lower
2001	0.090	0.079	0.082
2003	0.079	0.057	0.071
2004	0.097	0.070	0.099
2006	0.067	0.051	0.071
2009	0.077	0.052	0.072
2011	0.056	0.041	0.055
2014	0.067	0.048	0.054
2016	0.031	0.028	0.032

Figure 3. Mean growing season chl *a* and TSS measured in Aliceville Reservoir, April-October, 2001-2016. Bar graphs consist of mainstem and embayment stations, illustrated from upstream to downstream as the graph is read from left to right. Chl *a* criterion applies to the growing season mean of the lower station only.



	Upper	Coal Fire Ck	Lower
2001	11.12	18.31	12.08
2003	24.56	18.77	18.26
2004	17.01	22.05	17.11
2006	17.33	18.70	14.94
2009	14.02	13.93	11.75
2011	20.52	15.61	15.18
2014	16.29	18.12	18.71
2016	14.67	14.29	13.81



	Upper	Coal Fire Ck	Lower
2001	18.29	16.86	22.50
2003	31.86	20.14	24.20
2004	20.29	16.14	17.60
2006	14.14	12.86	14.86
2009	12.57	9.29	9.50
2011	9.14	9.14	10.29
2014	21.7	11.0	27.6
2016	11.1	11.7	11.8

Figure 4. Monthly TN concentrations measured in Aliceville Reservoir, April-October 2016 vs. average monthly discharge**.** Monthly discharge acquired from USGS Tombigbee River gage 02444160 at Bevill Lock & Dam near Pickensville, AL. Each bar graph depicts monthly changes in each station. The historic mean (1992-2016) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations.

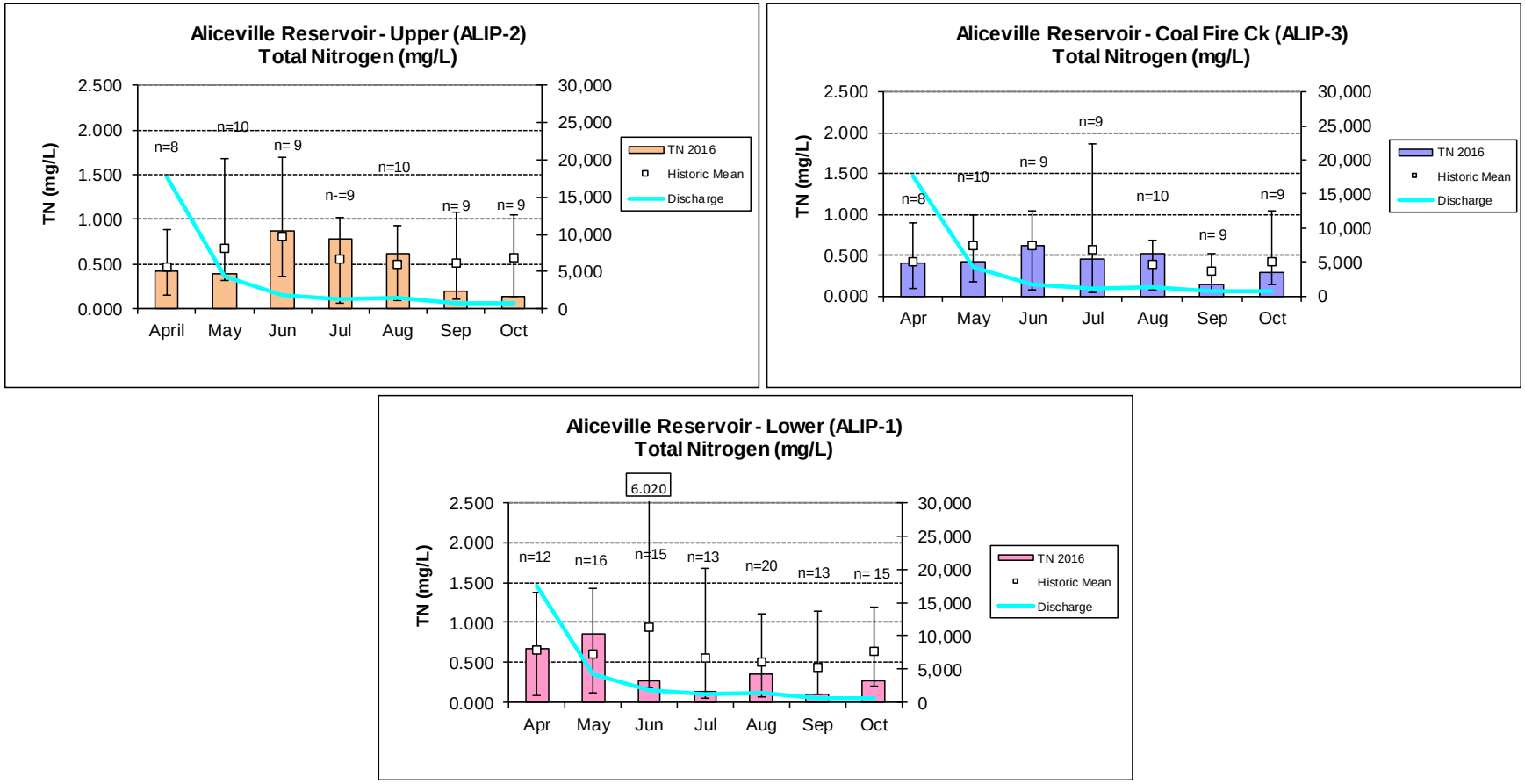


Figure 5. Monthly TP concentrations measured in Aliceville Reservoir, April-October 2016 vs. average monthly discharge**.** Monthly discharge acquired from USGS Tombigbee River gage 02444160 at Bevill Lock & Dam near Pickensville, AL. Each bar graph depicts monthly changes in each station. The historic mean (1992-2016) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations.

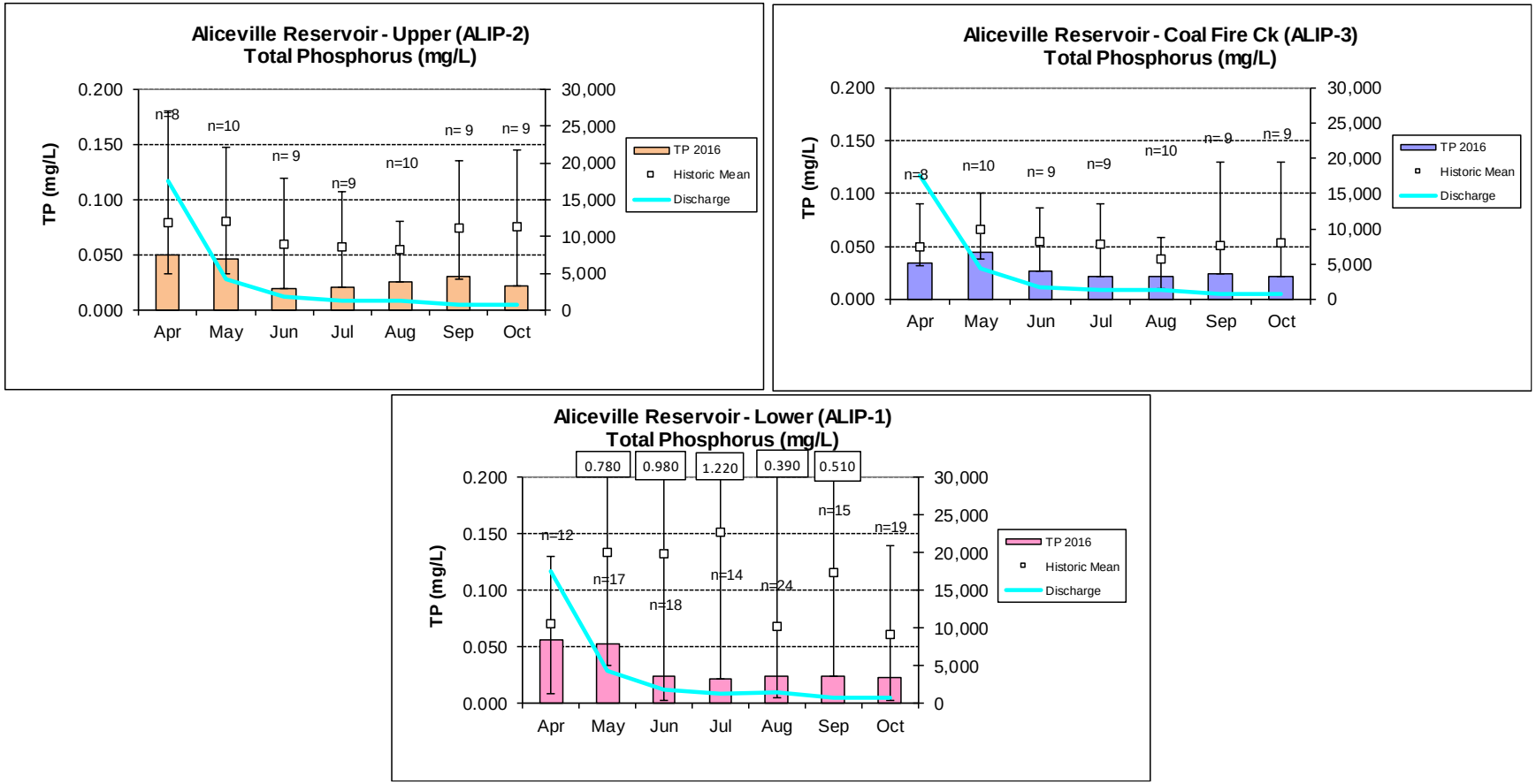
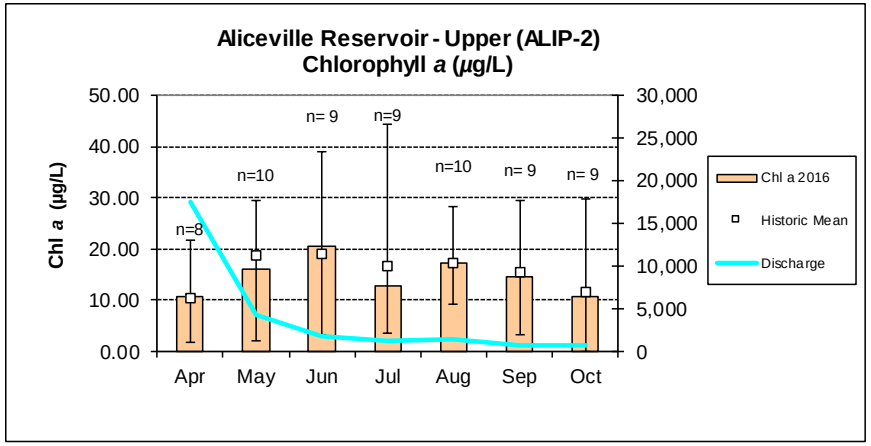
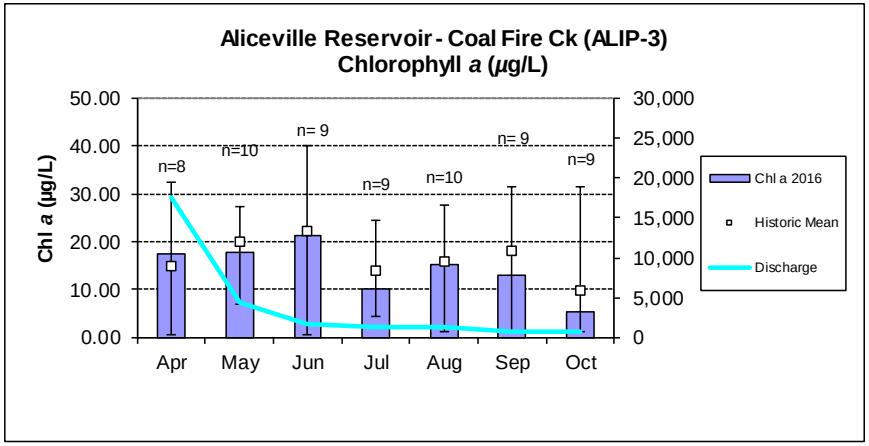


Figure 6. Monthly chl *a* concentrations measured in Aliceville Reservoir, April-October 2016 vs. average monthly discharge**.** Monthly discharge acquired from USGS Tombigbee River gage 02444160 at Bevill Lock & Dam near Pickensville, AL. Each bar graph depicts monthly changes in each station. The historic mean (1992-2016) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations.





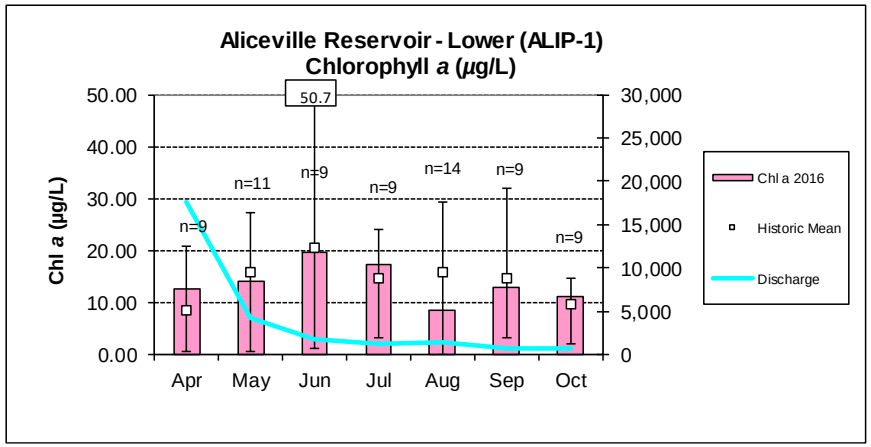
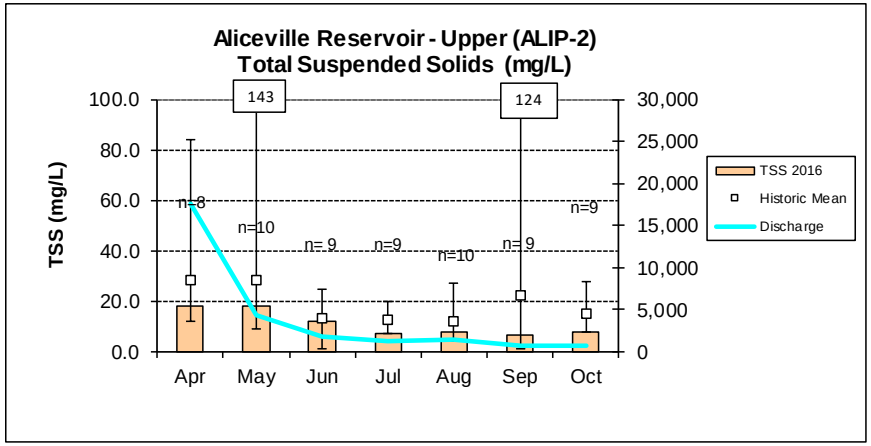
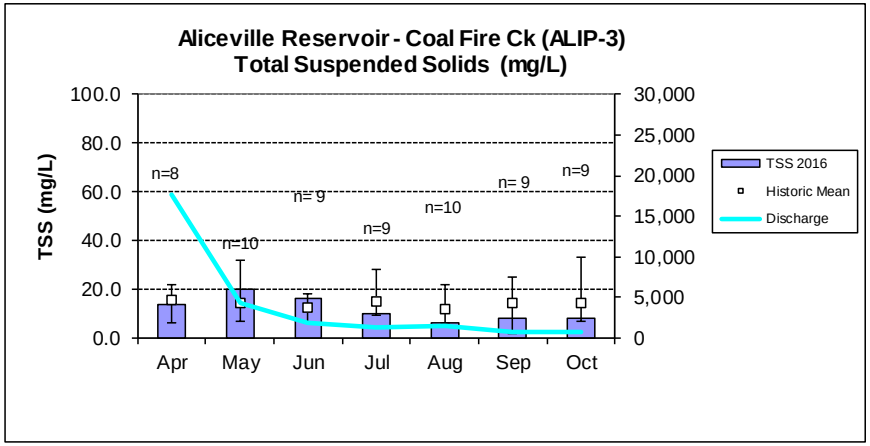


Figure 7. Monthly TSS concentrations measured in Aliceville Reservoir, April-October 2016 vs. average monthly discharge**.** Monthly discharge acquired from USGS Tombigbee River gage 02444160 at Bevill Lock & Dam near Pickensville, AL. Each bar graph depicts monthly changes in each station. The historic mean (1992-2016) and min/max ranges are also displayed for comparison. The "n" value equals the number of data points included in the monthly historic calculations.





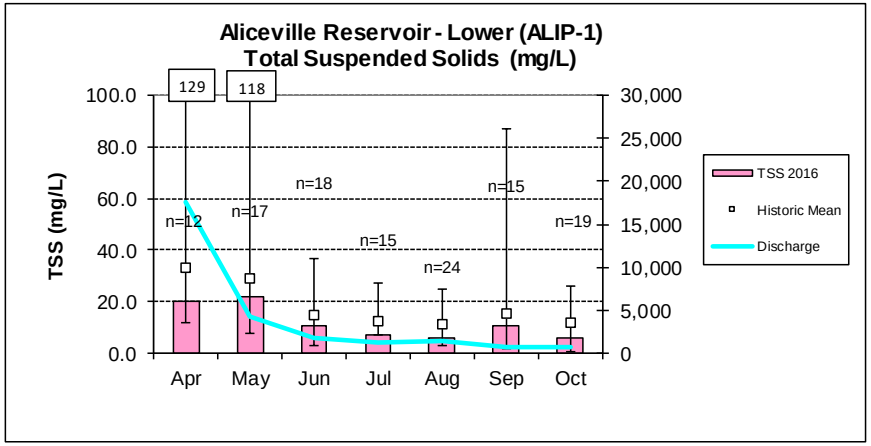


Table 2. Algal growth potential test results (expressed as mean Maximum Standing Crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes; values below 20 mg/L MSC are considered protective of flowing streams and rivers. (Raschke and Schultz 1987).

Station	Upper		Coal Fire Ck		Lower	
	MSC	Limiting Nutrient	MSC	Limiting Nutrient	MSC	Limiting Nutrient
2001	4.88	Nitrogen	*	*	1.79	Nitrogen
2006	4.61	Nitrogen	3.72	Nitrogen	5.14	Nitrogen
2011	25.43	Nitrogen	*	*	9.95	Nitrogen
2016	3.14	Nitrogen	*	*	2.93	Nitrogen

***** No AGPT sample collected at this location.

Figure 8. Monthly DO concentrations at 5 ft (1.5m) for Aliceville Reservoir stations collected May-October 2016. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth (ADEM 2019). In tributaries, when total depth was less than 3 m, criteria apply to the mid-depth reading.

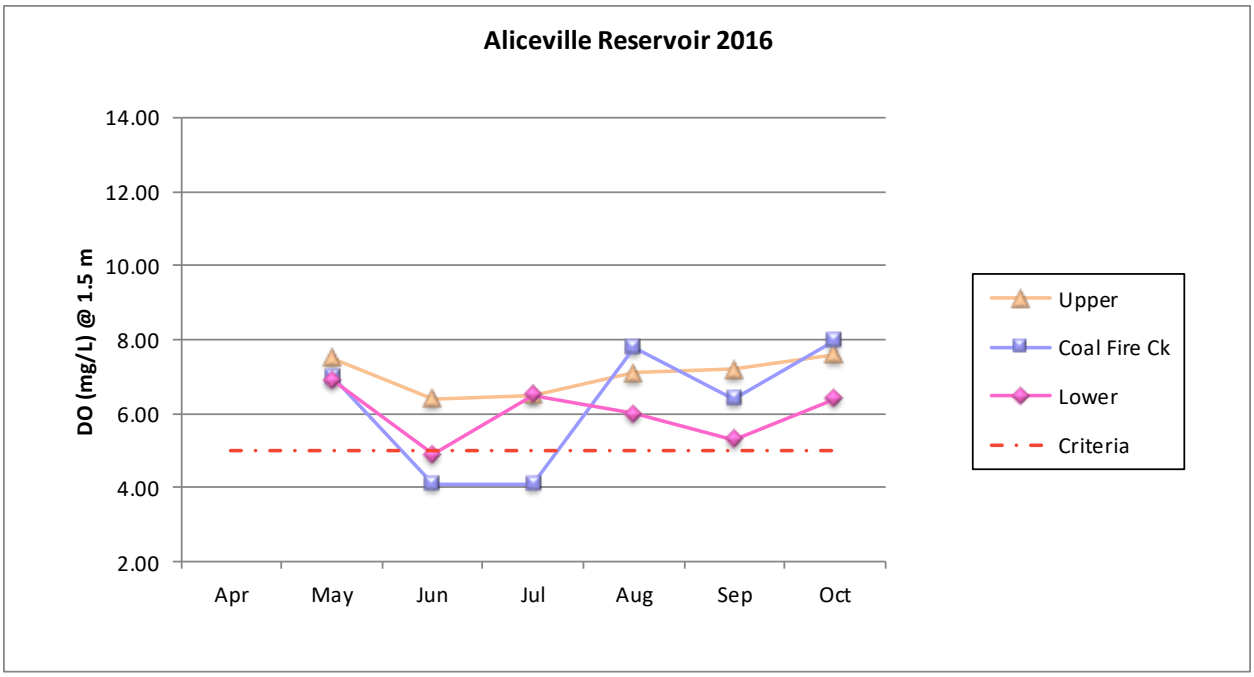


Figure 9. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C), and conductivity (umhos) in the lower Aliceville Reservoir station, May-October 2016.

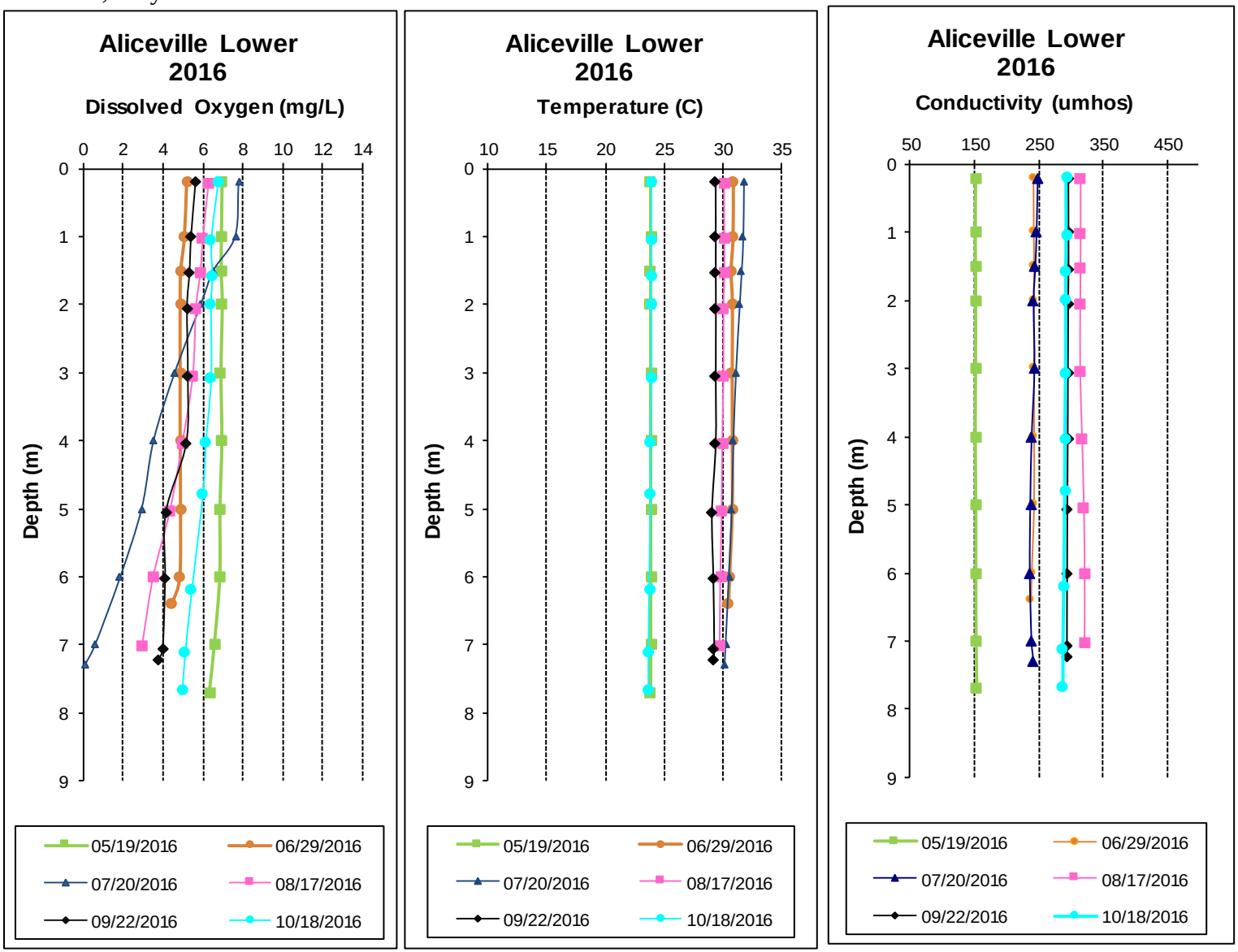


Figure 10. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C), and conductivity (umhos) in the upper Aliceville Reservoir station, May-October 2016.

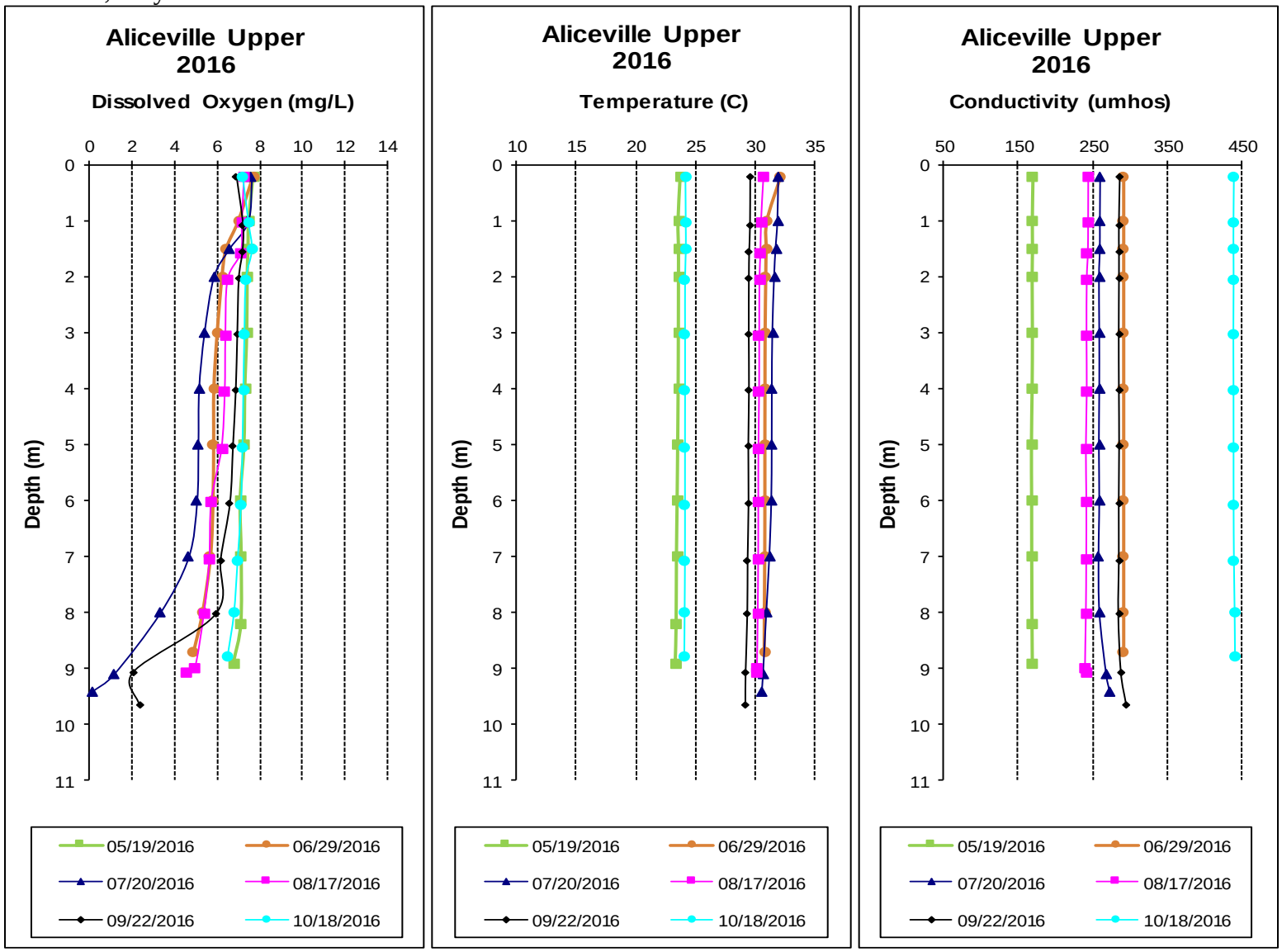
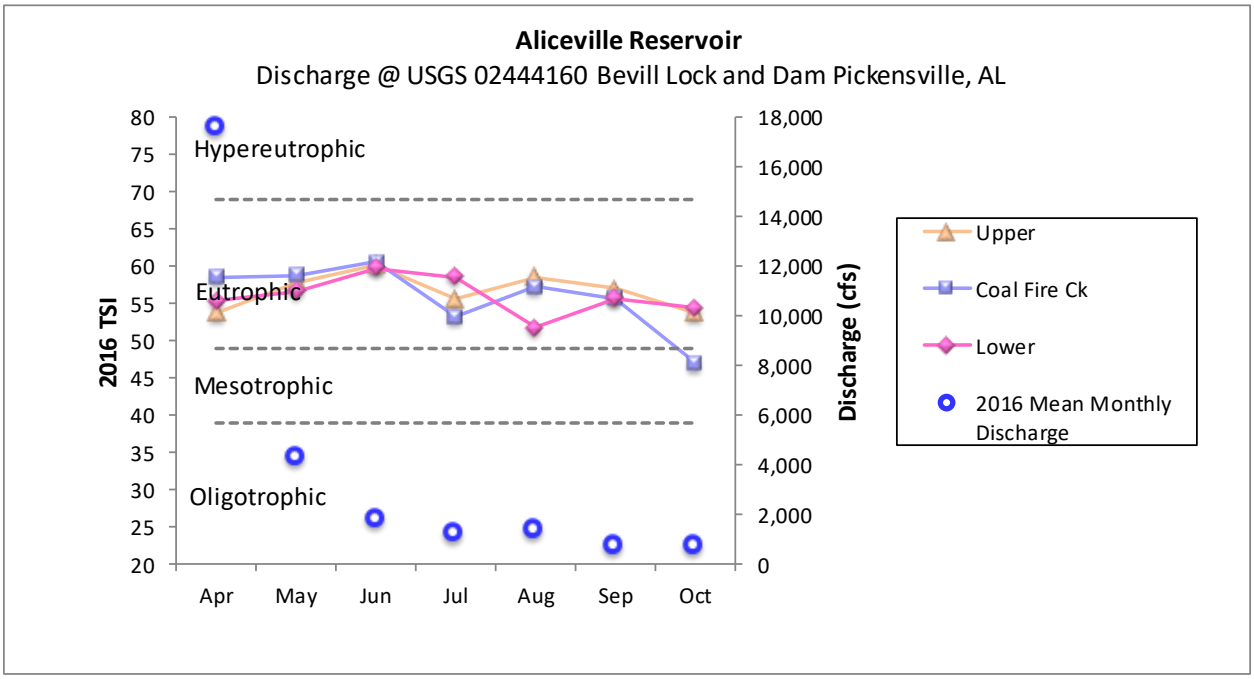


Figure 11. Monthly TSI values calculated for Aliceville Reservoir stations using chl *a* concentrations and Carlson's Trophic State Index calculation, April-October 2016. Monthly discharge acquired from USGS Tombigbee River gage 02444160 at Bevill Lock & Dam near Pickensville, AL.



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APPENDIX

Appendix Table 1. Summary of water quality data collected April-October, 2016. Minimum (min) and maximum (max) values calculated using minimum detection limits when results were less than this value. Median (med), mean, and standard deviation (SD) values were calculated by multiplying the MDL by 0.5 when results were less than this value.

Station	Parameter	N	Min	Max	Med	Mean	SD
ALIP-1	**Physical**						
	Turbidity (NTU)	7	8.2	34.0	9.3	16.6	11.8
	Total Dissolved Solids (mg/L)	7	72.0	232.0	175.0	168.6	61.4
	Total Suspended Solids (mg/L)	7	6.0	22.0	10.6	11.8	6.6
	Hardness (mg/L)	4	80.5	101.0	86.6	88.7	8.9
	Alkalinity (mg/L)	7	35.1	48.2	43.5	43.3	4.4
	Photic Zone (m)	7	1.19	2.99	2.16	2.10	0.67
	Secchi (m)	7	0.38	1.06	0.94	0.80	0.25
	Bottom Depth (m)	7	6.4	8.0	7.3	7.3	0.5
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.007	0.070	0.004	0.022	0.026
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.002	0.129	0.002	0.032	0.054
	Total Kjeldahl Nitrogen (mg/L)[J]	7	0.095	0.760	0.273	0.348	0.235
	Total Nitrogen (mg/L)[J]	7	< 0.096	0.851	0.274	0.380	0.281
	Dis Reactive Phosphorus (mg/L)[J]	7	< 0.003	0.012	0.004	0.006	0.004
	Total Phosphorus (mg/L)	7	0.021	0.056	0.024	0.032	0.015
	CBOD-5 (mg/L)	7	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	7.1	57.1	36.7	36.4	19.9
	Biological						
	Chlorophyll a (mg/m³)	7	8.68	19.60	13.00	13.81	3.69
	E. coli (MPN/DL)	4	2	17	3	6	7
ALIP-2	**Physical**						
	Turbidity (NTU)	7	7.1	29.3	9.3	14.2	9.7
	Total Dissolved Solids (mg/L)	7	79.0	364.0	168.0	187.0	92.8
	Total Suspended Solids (mg/L)	7	6.6	18.0	8.0	11.1	5.0
	Hardness (mg/L)	4	77.9	98.8	85.2	86.8	8.8
	Alkalinity (mg/L)	7	32.9	50.4	44.2	43.7	5.3
	Photic Zone (m)	7	1.36	3.22	2.64	2.47	0.78
	Secchi (m)	7	0.43	1.15	1.01	0.89	0.28
	Bottom Depth (m)	7	8.7	9.9	9.0	9.2	0.5
	Chemical						
	Ammonia Nitrogen (mg/L)[J]	7	< 0.007	0.040	0.004	0.013	0.016
	Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.002	0.121	0.002	0.028	0.048
	Total Kjeldahl Nitrogen (mg/L)[J]	7	0.135	0.867	0.330	0.462	0.293
	Total Nitrogen (mg/L)[J]	7	< 0.136	0.869	0.418	0.490	0.281
	Dis Reactive Phosphorus (mg/L)[J]	7	0.003	0.011	0.004	0.006	0.004
	Total Phosphorus (mg/L)	7	0.019	0.050	0.026	0.031	0.012
	CBOD-5 (mg/L)	7	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	8.9	91.2	42.0	41.8	27.0
	Biological						
	Chlorophyll a (mg/m³)	7	10.70	20.50	14.70	14.67	3.62
	E. coli (MPN/DL)	4	1	5	3	3	2

Station	Parameter	N		Min	Max	Med	Mean	SD
ALIP-3	**Physical**							
	Turbidity (NTU)	7		9.3	32.6	10.5	16.4	9.3
	Total Dissolved Solids (mg/L)	7		55.0	245.0	133.0	148.8	70.6
	Total Suspended Solids (mg/L)	7		6.0	20.0	10.0	11.7	5.1
	Hardness (mg/L)	4		64.6	91.2	73.2	75.6	11.6
	Alkalinity (mg/L)	7		16.7	41.8	38.7	35.5	9.0
	Photic Zone (m)	7		1.30	2.90	2.25	2.05	0.56
	Secchi (m)	7		0.55	1.18	0.91	0.82	0.24
	Bottom Depth (m)	7		3.3	4.1	4.0	3.9	0.3
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.007	0.050	0.004	0.015	0.019
	Nitrate+Nitrite Nitrogen (mg/L)	7	<	0.002	0.044	0.002	0.013	0.020
	Total Kjeldahl Nitrogen (mg/L)[J]	7		0.143	0.624	0.380	0.398	0.157
	Total Nitrogen (mg/L)[J]	7	<	0.144	0.626	0.421	0.411	0.156
	Dis Reactive Phosphorus (mg/L)[J]	7	<	0.002	0.005	0.002	0.003	0.002
	Total Phosphorus (mg/L)	7		0.021	0.045	0.024	0.028	0.009
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		4.0	61.5	31.8	33.1	21.4
	Biological							
	Chlorophyll a (mg/m³)	7		5.34	21.40	15.10	14.29	5.38
	E. coli (MPN/DL)	4		3	62	6	19	29

J=one or more values provided are estimated; < = Actual value is less than the detection limit.